

Application of biotic indicators for evaluation of sustainable land use—current procedures and future developments

Elisabeth Osinski^{a,*}, Uwe Meier^b, Wolfgang Büchs^b,
Joerg Weickel^c, Bettina Matzdorf^d

^a Chair of Agricultural Economics, Center of Life and Food Sciences, Technical University Munich,
Alte Akademie 14, Freising 85350, Germany

^b Federal Biological Research Centre for Agriculture and Forestry, Messeweg 11/12, Braunschweig 38104, Germany

^c Landesanstalt fuer Pflanzenbau und Pflanzenschutz Rheinland-Pfalz, Essenheimer Straße 144, Mainz 55128, Germany

^d Bettina Matzdorf, Zentrum fuer Agrarlandschafts- und Landnutzungsforschung (ZALF), Institut fuer Sozioökonomie,
Eberswalder Street 84, Muencheberg D-15374, Germany

Abstract

Indicators in the field of bio-diversity and landscape are applied on various levels, including the continental field as well as the individual agricultural enterprise. Apart from the ecological evaluation of agricultural enterprises and agrarian policy measures, indicators are also used in environmental reporting and evaluation as well as in planning or simulation models in administrative and scientific fields. Already for longer period of time, indicators have been used as assessment criteria in landscape planning to support decisions regarding land use. Due to the standards the EU commission requires from the member states in this regard, the application of indicators to assess the effects of agri-environment programs have gained prominence. The EU requires proof of the achievement of the promotion aims such as soil (erosion, nutrients, plant-protective agents), water, bio-diversity and landscape (EU/VO 12004/00).

This commitment can be met by means of a functioning environmental reporting. However, only an insufficient number of suitable indicators exist in the fields of bio-diversity and landscape. In a bottom-up approach, control systems to assess ecological farming achieved on an operational level for a future development were recently developed. Here, a future development is seen in the alignment referring to results or goals, respectively, and in the regionalisation. The article gives an overview of the indicator application on different spatial levels and for different purposes.

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1. Application objectives of indicators in the fields of bio-diversity and landscape

The necessity to develop indicators in the fields of bio-diversity and landscape has already been sufficiently documented (OECD, 1997, 2001; KOM,

2001a,b). The common goal is a standardised assessment leading to world-wide comparable results. When developing indicators, their different applications must be taken into consideration. Apart from the objectives to be obtained, the application of indicators vary with regard to their spatial reference. Attempts to provide and apply indicator systems already exist on a European (respectively continental), national as well as regional and local level, the latter also including the scale of agricultural enterprises.

* Corresponding author. Tel.: +49-8161-71-4461;

fax: +49-8161-71-4426.

E-mail address: osinski@wzw.tum.de (E. Osinski).

By means of indicators, the compliance of development processes with sustainable development on a national and international level are tested (Muessner et al., 2002). In larger regional units, the use of indicators is mostly limited to the evaluation of time rows of land use changes, of potential stress factors or the development of a specific species population. In large areas, an average has to be found between extremely aggregated characteristic values belonging mostly to pressure indicators, and the sectorial view of various species or groups of species with an indicative character. The smaller the observed area, the more characteristic values can be surveyed and a description of the cause and effect relations is more likely. Besides the influence on the biotic resources caused by an enterprise, the actual condition can also be registered immediately. This control can not only be used to verify agricultural practice with regard to its environmental relevance, but also to estimate the effect of the measures of agri-environment programs. The application fields stated include an ex-post-evaluation.

Another field for the application of indicators refers to a future-oriented assessment of planned measures. Due to the fact that the entire system observed cannot be shown in the field of planning, the use of indicators here is also of necessity.

Therefore, indicators must comply with the problems shown and the spaces for which they must be valid. Basically, the application fields of indicators can be defined as follows:

- Assessment of agrarian enterprises.
- Assessment of efficiency of political measures.
- Environmental reporting/environmental monitoring.
- Assessment within a planning framework.

The contributions of this volume for the application of indicators can be classified, with regard to the above-mentioned application of assessment of environmental effects of agricultural enterprises (Roth and Schwabe, 2003; Heyer et al., 2003; Oppermann, 2003; Braband et al., 2003) or the evaluation of agri-environmental measures (Marggraf, 2003; Menge, 2003) as a specific form of political intervention into agricultural action. The contributions stated, deal primarily with agri-environmental indicators, since agriculture, due to its superficial extension, heavily influences bio-diversity and land-

scape. Additionally, an overview of approaches on the integration of nature protection aims into operational management is given.

Even though the knowledge of agri-environmental indicators is still incomplete and a continuous development of the methods for the derivation of indicators is necessary, there already exists the necessity of using operational indicators for bio-diversity and landscape (comp. Larsson and Esteban, 2000).

Depending on the objective and the spatial reference of the application, the claims vary, i.e. to the transferability, the extent of investigation and the availability of data. In the following section, the application of indicators according to the requirements of the OECD (1997) in the various, above-mentioned fields is examined more closely with regard to the measurability of indicators, the policy relevance and transferability of application and the problems, namely the political soundness of landscape protection and bio-diversity.

2. Assessment of agrarian and forestal enterprises

2.1. On-farm assessment

With regard to environmental reporting, changes of environment state indicators or changes of pressure indicators, respectively, are documented. Through this approach, the cause factors remain anonymous. On the assumption that an improvement of the environmental state can be initiated by environment observation, the inclusion of the cause factors is necessary. In the field of the a-biotic resource protection, legal regulations for the reduction of emissions (fertiliser regulations, plant protection law, water protection regulations) have already been determined. In the field of the biotic resource protection in Germany there have been improvements, for one in the specification of legal provisions (republication of the Federal Nature Conservation Law which, for example, should regulate the minimum provision of landscapes with biotopes), secondly it has been attempted to improve agricultural and industrial operations through self-commitment or certifying procedures. The impact on a-biotic and biotic resources is coming from a single farm and can be classified according to farming intensity and the extent of measures.

The interaction of measure and location implies a certain effect on the respective protected good. If one wants more than an overview on the efficiency of agricultural measures on biotic resources, one has to focus on the agricultural enterprise. From this idea, operational control procedures have been developed in order to determine the certain degree of environmentally friendly farming of the enterprises. In some of these control systems biotic aspects have already been implemented (see compilation by Braband et al., 2003), while in others a-biotic factors are controlled. The systems are implemented either by experts or by the farmers themselves. The purpose of most of the procedures is to document the existing farm stock, wild species, biotopes, landscape elements and land use types. However, it is not enough to require the documentation of species or structures when they are not connected to a quantitatively or a qualitatively evaluating statement. An evaluation of the actual state can only be effected if corresponding reference values are determined. The contributions from Roth and Schwabe (2003) as well as from Oppermann (2003) consider specific regional characteristics and compare the stock with a target value.

As a relevant indicator, Roth and Schwabe (2003) present ‘the ecologically and culturally important surfaces of the agrarian region’ (OELF). A modified form of this structure indicator is also applied in other systems (see contribution of Braband et al., 2003). Instead of remaining at a statement regarding the actual state, the authors put it in relation to the set target by evaluating plans for the use and cultivation of the respective agrarian region. Through this way, deficits can be determined and compensated. With the above-mentioned plans, the State of Thuringia has, together with some states (Bavaria, Saxony-Anhalt), possess secure environmental planning approaches. Most states in Germany do not have information about the desired surface values for ecologically relevant structures. These objectives, however, are prerequisite for an effective application of indicators.

Oppermann’s contribution (2003) surmounts the documentation and determination of the deficits in the field of ecologically relevant areas. The ‘nature balance scheme for farms’ (Oppermann, 2003) contains four assessment fields which can be carried out on an operational level without large-scale data surveying. Apart from structure-related fields, the indicators

also describe the fields of bio-diversity (richness of species) and field management (i.e. farming intensity). Besides the documentation, points for the evaluation of the condition of the enterprise with regard to the various indicators are awarded. Even here, the actual objective comparison is formulated regionally specific. However, here it also has to have a qualitative value due to fact that in natural green space a specific list of species potentially occurring in this region from which a minimum of species should exist.

The amount of effort required for the data collection is a common criticism of operational assessment procedures. In order to lower this amount of work, Oppermann (2003) checks if the number of indicators, 47, may be reduced. He therefore identifies the results concerning the richness of species as characteristic for the remaining results. This means that the total number of given points for the enterprise is best correlated with the percentage of species rich areas. The question being, if the surveying of species is sufficient for an operational assessment. This would simplify the operational assessment process.

The relevance of the collected data for the correct image of the agrarian eco-systems cannot be evaluated by applying the presented operational assessment systems. However, there exists a significant tendency for the systems to determine action-related indicators, which are easier to collect, than result-oriented indicators. Nevertheless, one must take into consideration that the paid actions do not necessarily lead to the expected results. If on the other hand only results are paid, the procedure leading to these results cannot be clearly determined and thus they are not payable in the strict sense of payment.

Generally, the assessment of the state of bio-diversity on an operational level rising above simple indicator types such as single target species is considered to be too complicated. Since the varying quality and quantity of seasonally and annually appearing biotic indicators has been criticised in the past, the collection of easily measurable a-biotic factors was proposed. Measurements try to prove that a connection exists between the farm management, the subsequently measured changes of a-biotic factors and the consequences for indicator organisms (Heyer et al., 2003). Therefore, one tries to unify the effect of certain agricultural implementation procedures on biotic aspects. A verification of this thesis at different

positions is still pending. However, in individual cases it is necessary to clarify and to secure the reference of the a-biotic indicator to the respective biotic indicator before been able to use the first one.

The section “Application of indicators” is rounded up by a contribution from Braband et al. (2003) which analyses various operational assessment procedures and cites points of criticism also relevant for other indicator systems. This also confirms that mostly action-oriented indicators are rewarded, although from a scientific point of view, the effects of these actions cannot be entirely predicted. On the other hand, actions that are not rewarded, would therefore only show an effect after a long period of time, even though they would be of use for environmental policy. However, a better transparency of the action-oriented indicators is significant.

Only in a few systems is the quality of non-cultivated agricultural areas taken into consideration. In most cases, only the area size is taken into account.

When characterising the agricultural areas either actions or, in the case of result compensation, the number of field products or the species of the accompanying flora and fauna are characterised.

The assessment systems compared in this abstract can partly be developed even further towards more result-oriented indicators. A prerequisite, however, is the concretion of the objectives and above all public discussions.

Furthermore, the integration of farmers into the assessment procedure seems to be of importance in order to become conscious of the effects the measures can have on the bio-diversity of an agricultural enterprise. For this, the farmers’ knowledge in the area of bio-diversity must be improved (also see Kleijn et al., 2001). Oppermann (2003) indicates that the farmers in the Black Forest were open for ecological procedures on their farms and were prepared to accept criticism after noticing unexpected positive aspects. However, a change in thinking is necessary to not only include a fixed implementation of indicators, but also to reflect together with farmers on how to achieve optimal effects for the environment.

Another development direction pursues a stronger formalisation of control procedures. As an enhancement of the procedure KUL (criteria of environmentally justified agriculture), a certification procedure (USL: Environmental securing system agriculture) has

been proposed to give the farmers a market advantage as it certifies ecological compatibility (VdLufa, 2001).

The certification procedures, so far only used in ecological farming, would therefore be extended with regards to environmental compatibility. A prerequisite is the registration by the indicators of the strains and the utility of the agriculture and the acceptance of the defined tolerance ranges.

2.2. Criteria systems and environmental management to assess performance in nature conservation by agrarian and forestal enterprises

Trust and credibility are always interlinked with an assessment. In this respect, existing structures, for example in agriculture, which as such are credible or not, can only be assessed with regard to previously determined evaluation parameters, like test criteria. In the 1990s, criteria-oriented evaluation of agricultural enterprises has become increasingly established in practice. Practical criteria systems are briefly introduced and compared. None of the criteria systems uses bio-indicators to prove that a conservation measure enhanced bio-diversity. Rather it is assumed that measures specifically directed at protecting biotic resources will “per se” have positive effects on bio-diversity. This is a pragmatic and controllable approach which should be maintained and promoted as long as there are no reasonable economic and ecological alternatives.

2.2.1. Environmental management systems and nature conservation

The existing environmental management systems, Regulation EC (2001) and ISO 14001 (1996), do not provide for biological indicators to measure the starting situation and the success of measures in securing bio-diversity. When the protection of biotic resources is integrated into the operating structures and processes of an agricultural enterprise, it is assumed that measures to preserve bio-diversity, such as integrated land management or habitat networks are in fact serving to protect biotic resources.

Under the two environmental management systems mentioned above, integrated crop growing could help to permanently improve the protection of biotic resources in cultivation areas if clear provisions and criteria are defined for that purpose. Integrated crop

cultivation is a minimum standard suitable for the integration into environmental management schemes. It aims for a continuous improvement of the environmental situation, and allows the measurement of adherence to the principles, and accounting of the site conditions. Connected aquatic and terrestrial succession zones can be set up outside the growing areas. They would serve to maintain bio-diversity in line with the intention of the agrarian environmental management systems. Bio-diversity on the actual cultivation area could be furthered by ecological-oriented cultivation, but is not necessarily required by standardised environmental management systems.

2.2.2. Environmental criteria systems in plant growing

Environmental criteria systems are based on environment-oriented performance criteria. On that basis, a company may allow inspectors to evaluate it for its environmental performance. If the evaluation is successfully, the company may use this fact for publicity, for example, by displaying this on a specific label.

Protection of biotic resources is anchored in each system, but with varying binding functions, and with varying solution approaches, depending on the production direction. The basic assumption is that a reduced input of substances, environmentally gentle cultural measures and straight nature-conservative measures in and outside the actual productive area are sufficient. None of the criteria systems require any scientific proof of the success of each individual measure, for instance on the basis of bio-indicators. The reason being that there are no general bio-indicators for all the different cultivation systems in the different climatic regions. Even if any were available, the effort required for inspection and verification would be too high in terms of time and money. Therefore, any measures of nature conservation implemented and documented will count as a success for nature conservation.

[Euro-Retailer Produce Working Group of Good Agricultural Practice \(EUREP GAP\) \(2002\)](#) is a co-operative by a number of leading European retail companies. The EUREP system consists of 'required' and 'encouraged' criteria. 'Required' means the respective criteria must be fulfilled if an enterprise wants to participate in the program, 'encouraged'

means that the criteria specify an objective which is desirable to be achieved.

A key aim must be to enhance the environmental bio-diversity on farms through a conservation management plan.

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| Required: | Has a conservation management plan been established and have the growers considered how they can enhance the environment for the benefit of the local community and the flora and fauna? |
| Encouraged: | Do the growers understand and assess the impact their farming activities have on the environment and do they pursue nature conservation policy plans on their farms? Are the policies compatible with sustainable commercial production, and do they minimise influences on the environment as far as possible? |

The performance of a company with regard to the protection of biotic resources cannot be measured by EUREP criteria. It is the strategy of the EUREP system to first increase awareness of problems of nature conservation and protection of biotic resources, and then motivate farmers to enhance their understanding of these fields.

In the [Flower Label Program \(FLP\) \(2002\)](#), environmental criteria are based on the environmental criteria list by [Meier and Feltes \(1996\)](#) and on a relevant Internet publication by the Federal Biological Research Centre of Agriculture and Forestry ([BBA, 1996](#)). It is only possible to a very limited extent to protect biotic resources in areas of highly intensive protected flower cultivation. Yet FLP criteria include the requirement that healthy crop residues are composted, and that the compost is recycled into the production system. Apart from these soil conservation measures, FLP seeks solutions outside the production areas. This contributes to maintaining biological diversity outside the production areas and enhances the quality of living of residents near flower plantations, especially in developing countries, where workers and other people often live between the plantations.

The [Forest Stewardship Council \(FSC\) \(2000\)](#) wants to achieve, on a global scale, forest management which is at the same time economically buoyant and

compatible with nature and the human society. FSC certification is guided by 10 principles with 56 criteria. Some of the relevant criteria for biotic resource protection shall be presented here. Environmental impacts shall be assessed according to the scale and intensity of forest management and the uniqueness of the affected resources, and assessment results shall be adequately integrated into management systems. Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g. nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.

Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile eco-systems and landscapes, and, by doing so, maintain the ecological functions and the integrity of the forest.

The following ecological functions and values shall be maintained intact, enhanced, or restored:

- Forest regeneration and succession.
- Genetic, species, and eco-system diversity.
- Natural cycles that affect the productivity of the forest eco-system.

The **Pan European Forest Certificate (PEFC) (2002)** was introduced in 2000 as a product marketing label. The PEFC certificate is only awarded to forest companies following sustainable forest management guidelines and allowing inspections of the fulfilment of environmental and social criteria.

The wildlife and conservation policy is: planning of forest management and mapping of forest resources, including forest biotopes of ecological importance and taking into account protected, rare, sensitive or typical forest eco-systems, such as meadowlands, wet biotopes, habitats of endemic or endangered species, or endangered or protected genetic in situ resources.

The indicators for conservation are:

- Protection and promotion of rare tree and bush species.
- Historical ways of management which have produced valuable eco-systems, for instance, coppice forest, should be promoted in suitable places if economically viable.

- Maintenance and harvest measures shall be carried out so that they do not cause lasting damage to the eco-system. Wherever possible, steps to enhance bio-diversity shall be undertaken.

Rainforest Alliance (2002). A number of agricultural producers (bananas, coffee, citrus, sugar cane, cocoa) in Latin America voluntarily allowed their farms to be evaluated by the US-based environmental organisation 'Rainforest Alliance' for the fulfilment of social and environmental criteria.

The indicators for natural habitats are:

- A plan to conserve and recuperate different eco-systems within the farm that including a mapping of the boundaries of critical habitats such as wetlands, lagoons and wildlife roosting or nesting areas.
- Indiscriminate or unjustified deforestation is prohibited on farms.
- Incorporation of forested areas into private conservation easements, private reserves or government protection programs.
- Buffer zones around protected areas.

The indicators for reforestation are:

- Rivers should have a 10 m buffer in flat areas and 50 m on inclines greater than 30% (measured horizontally).
- Public roads that border or cross plantations should have a 10 m buffer of native vegetation.
- Areas not in production or not suited for production must be reforested.
- Vegetative barriers of 30 m required around schools, clinics and housing areas. These buffers should be designed to reduce pesticide drift. Production-related buildings (packing stations, showers and storage areas) should have a 10 m buffer zone.

The indicators for wildlife conservation are:

- Establishment of policies prohibiting hunting, collecting and trafficking.
- Consultation of national environmental legislation, specifically legislation related to wildlife protection and establishment of biological corridors.
- Company support of local research, particularly those projects recommended by the certification program.

3. Assessment of the effectiveness of political measures

The European Union, seeing the necessity of preservation measures for biological variety, has promoted the finding of so-called headline indicators as well as indicators for specific strategic instruments (KOM, 2001b). Therefore, the outcome of all strategies in total (headline indicator) and of single strategies can be checked. Additionally, there has been the desire that environmental issues should play a greater role in agricultural policies (COM, 2000). Since the 1980s there have already been efforts to include environmental aspects into the common agricultural policies. The 1992 EU agricultural policy reform enabled agri-environment programs to play an important role in agricultural development as the so-called second pillar. The EU stated the overall objectives with the guideline EEC 2078/92. Member states, however, could decide on the actual procedure (see Marggraf, 2003).

An evaluation of the individual member state programs is mandated by the EU guideline (EEC 746/96 Art. 16–20). An assessment is of importance for the further continuance of the programs as well as for the further inclusion of environmental issues in agricultural policies. The EU Commission expects the evaluations to provide insight into the effects of the implemented measures and suggests improvements (COM, 1998).

A common assessment method for these programs has not yet been developed, in part due to the lack of experience with these new programs. However, the measures prescribed by these programs are quite similar. This has enabled Wilhelm (1999) to evaluate the programs with regard to their ecological effectiveness. Three different location types with different agricultural suitability were to be assessed by ecologists on the program effectiveness. The measures, being quantifiable through the assignation of proportion factors, became functions of indicators. The measure sets of each program were linked together with the implementation area. This allowed a comparison between the different programs and an assessment of the ecological relevance. The programs have to be classified according to their scope, either broad and not specific or narrow and very specific, and the size of the implementation area, for example, either an agricultural area

for a whole state or by certain criteria selected regions (e.g. specific wetland). The ecological assessment concentrates exclusively on the implemented measures and their effects. This assessment is then used for an economic assessment of the programs. This is done by comparing the sum of the ascertained ecological points with the expenditures required for these. The ecological points are derived from the sum of the indices of the individual measures. By using a theoretical approach for economic assessment, Marggraf (2003) does not establish the actual effects of the implemented measures. The official evaluation report also stated that the implementation area usually depicted the most used indicators (COM, 1998).

This approach was also used in the State of Saxony-Anhalt for the assessment of an agri-environment program for environmentally friendly cultivation (Menge, 2003). The distribution of the measures acceptance was determined with help of a descriptive statistical method. The surveyed farms were classified according to biotic resource preservation indicators. These classifications included the following: species diversity, resistance factors, percentage of legumes and grains, fallow duration and field size. The indicators are ascertained and averaged out through all farms. An indicator development over many years may show developments with regard to environmentally related effects. A defining beforehand of objectives or goals is not recommended. An assessment of these should be done after documentation of the development process. This declaration remains indirect since a monitoring of the immediate changes in the area of bio-diversity was not undertaken. The use of these indicators, however, is not equivalent to the assessment of the actual effectiveness of the measures on the implementation areas in relation to the sensitivity of the areas to a certain impact (Osinski, 2002). Through this way, measures with positive effects can target the right locations.

Because of the immense effort and time required for these measures to show positive environmental effects, assessment of agri-environment programs are dependent on the indirect approach. However, studies in The Netherlands have shown that a direct evaluation is necessary. A comparison of the biotic makeup of areas with and without management agreements showed no positive effects on the avian and plant population due to this form of agriculture (Kleijn et al., 2001). The

authors therefore suggest a scientific component for the implementation of agri-environment programs. The EU Commission (KOM, 2000) handed out an indicator criteria catalogue for the assessment of these programs within Europe. This catalogue should then prove the success of the implemented measures. The indicators included, for the areas of bio-diversity and landscapes, concentrated on data of the implementation area and the surveying of species population (mammals, birds) (KOM, 2000, Section D). The actual assessment, however, is responsibility of each member state. In the case of a species survey this must be done on the basis of a local analysis. Because of this, the assessments concentrate on individual local areas or specific farms. For this approach, a mixture of measure-oriented and result-oriented indicators was chosen, similar to the operational assessment approach.

A key issue in the assessment of these programs is which qualities and what quantities of bio-diversity and landscapes are of relevance. What results are desired from 'good agricultural practice' and which results are going beyond? It is hoped that the establishing of a national framework with minimum requirements and control criteria would solve this issue in Germany (Knickel et al., 2001). However, the determining of these minimum requirements is difficult due to the lack of a common reference system and because of the immense variety on the regional, nature and agricultural level.

Thus, the discussion of 'good agricultural practice' and its development through the use of indicators is far from over. Action-oriented and result-oriented approaches have also been discussed (Knickel et al., 2001). An example of result-oriented system is the 'target species concept' of the State of Baden-Wuerttemberg's landscape program (Walter et al., 1998). This concept provides the currently most comprehensive approach for the determination of species-related minimum requirements at the natural units' level. This concept determines the type of indicators as well as the desired population sizes.

Such an approach would also allow the separation of the requirements for good agricultural practice from ecological services. This would avoid the so-called 'carry-on effect' and increase the 'ecological accuracy' of agri-environment programs (Hampicke, 2000).

There have already been suggestions on how a separation with regard to economic assessment could be implemented. Therefore, normally operated conventional agriculture would not receive government subsidies in the long run. However, if nature conservancy aspects are included, a limited compensation is possible. This would mean that traditional, integrated and ecological-oriented agriculture would only receive medium compensation, while landscape preservation services would receive the highest level of compensation (Knickel et al., 2001). These services however, have to be specified with help of indicators.

4. Environmental reporting/environmental monitoring

There have been political efforts, both on the national level, e.g. in Australia (Pearson et al., 1998) or England (MAFF, 2000) and European level (COM, 1999) to develop indicators that primarily concentrate on reporting and monitoring. They should control the environmental condition and evaluate the effectiveness of the implemented measures. National and international environmental indicator systems were developed in order to improve the information and communication of environmental conditions, the prioritisation within environmental policy and to determine environmental objectives (see Walz, 1997). The political importance of this was emphasised on the Helsinki Summit, where also an indicator system for the European level was designed. The architecture of this system is made up of so-called environmental-specific core indicators (these allow only individual indicators from each of the core areas) and of sector-specific indicators (COM, 1999). One of these core areas is 'Nature and Bio-diversity' whose indicator 'Species Catalogue of the basis of genetical variety and variety of biotopes' is still to be developed. Advances in the agricultural sector have been immense, especially under the efforts of the OECD Commission and the individual member states. A list of agri-environmental indicators exists, some of which have already been partly implemented. The achieved results have also been documented (OECD, 2001).

In many countries (for example, The Netherlands, Sweden, Norway, Canada) the development of indicator systems was based on the OECD

pressure-state-response approach (OECD, 1997). The emphasis is either on pressure indicators (The Netherlands) or on state indicators (Sweden) (Walz, 1997). The biggest difficulty in the development of indicator systems, however, is the determination of the correct parameters of the effect systems. It is common to characterise stress parameters through the use of indirect indicators. Factors that influence the decline of species and biotopes include the increased agricultural intensity, the resulting destruction of habitats and changes in the living conditions in habitats (OECD, 2001). Thus, a change in the areas of bio-diversity and landscapes can be derived from taking into account the development of these impact indicators. This indirect derivation, however, does not allow a documentation of clear cut causalities. A documentation of the changes in nature and landscapes in relation to the implemented measures can only be achieved through monitoring. Monitoring would not only determine individual stress or biotic parameters, but would also document both of them and place them in relation. A method for environmental random area sampling was developed for Germany (Statistisches Bundesamt and BfN, 2000). This method aims to survey the changes in so-called “normal landscapes”. This would allow agrarian and forestal areas in addition to conservation areas to be incorporated into a national test framework. This allows the collection of structural data as well as of data about the quality of the biotopes through a surveying of the species makeup. This comprehensive indicator system is currently the most advanced proposal for a monitoring approach in Germany. However, as it appears to be highly cost intensive it has not been put into practice.

There has been a strong demand for changes in the area of conservation of landscapes. Database surveys, that would allow a documentation of these changes on a national or European level, are even less available than for the area of bio-diversity. Proposals are available for respective indicators that would include natural coherence, diversity, and features as well as cultural identity, diversity and features (Wascher, 2000). As a prerequisite for successful monitoring, a documentation of European landscapes is needed first (see EEA, 1995). There have also been efforts on the German national level to categorise landscapes in order to better document their development. A research project financed by the national office for nature protection

(BfN) is targeted at characterising and standardising of high valued landscape types. Additionally, impacts are to be documented and suggestions for protection are to be made.

The main problems of a European indicator system lie in the incoherence of the available databases, especially for the areas of bio-diversity and landscapes (Brouwer, 1999). There are European institutions that are attempting to construct an integrated database. However, since they also rely on national surveys, the database is incomplete for certain regions and sometimes portrays European nature and bio-diversity insufficiently (Delbaere, 1998).

5. Other areas for indicator implementation

Besides the use in operational assessment, in the evaluation of agri-environment programs or environmental monitoring guidelines, indicators can also be of use in planning. Thus, the regional objectives of the concept of ‘Ecological and Cultural Significant Areas’ (OELF) is based on regional planning (Roth and Schwabe, 2003). These objectives, however, have to be first determined by defined methods. The plans used in that case are called ‘plans on the use and care of agrarian spaces (ANP) (Roth, 1996). These are comparable to landscape plans which are documenting the makeup of landscape elements and give target values for future development in agricultural landscapes.

Landscape planning per se and the construction of this kind of plan is unthinkable without the use of indicators. Landscape planning in Germany is the sector planning for nature protection and landscape care. It aims to provide a land use that enables to best preserve the potential of the land to maintain the a-biotic resources and the plants and animals (Spitzer, 1995). Therefore, the abstract concept of protecting ‘variety, peculiarity and beauties of nature’ (German Nature Protection Law, BNatSchG, 2002) have to be put in concrete terms with help of indicators.

The potential has to be first determined and then evaluated in order to then design respective measures for the protection, development and preservation. Each of these steps contain an abstraction of the reality. In Germany it is common to develop planning frameworks on the state level for the areas of species and biotope conservation. Such a planning framework

already exists in the target species concept of the State of Baden-Wuerttemberg. This concept lists not only the indicator types but also objective limits for the desired population size per usable area (minimum standard) and per protected biotopes (special population protection) (Walter et al., 1998).

Another area for the use of indicators is the environmental impact assessment (EIA, after BNatSchG, §18, 2002). EIA guidelines prescribe an assessment of the environmental compatibility of an implemented measure. The method of evaluation is still an experimental field (Koepfel et al., 1998) although there is a need for providing species-related data as an evaluation basis. Species are analysed following the criteria scarcity, degree of threat, number of species and individuals, dominance structure, diversity and evenness. Apart from this the impact evaluation includes the estimation of the threat which is put on the functionality of the area affected by the planned impact. For orientation a list of biotopes and impact-specific species groups suitable as indicators is provided (Koepfel et al., 1998).

The prerequisite for the determination of the conservation status of an area, for example, by the Nature Conservation Law (BNatSchG), is the occurrence of rare species. The occurrence of rare species following the so-called Red List of threatened plants and animals (e.g. Korneck and Sukopp, 1988) can be understood as an indicator to help in the assessment of the placing of the area under protective status. These indicators only represent the total number of species which are to be protected by law (BNatSchG, §1). The use of Red Lists is sometimes criticised because of different degrees of threats in different parts of the country. Thus, the Red List loses its character as tool for differentiating endangered and not endangered species. Another argument dealing with the use of Red Lists and its limit is mentioned by Garrelts and Krott (2002). By use of a so-called flagship species as single indicator it can be tried to influence political decision making. The example of the Great Bustard (*Otis tarda*) in Brandenburg demonstrated a negative effect on the use as an indicator. That species was given the role of the countries' development enemy. Only a few species living in that area had enough power to prevent building a motorway. The public could not accept the weighting of a few species at the limit of their habitat against the very important motorway. The authors of the article suggest instead of making decisions with the help of 'Red

List Species' they should be taken as 'Early-warning System' (Garrelts and Krott, 2002).

Models are becoming even more important for the planning of measures and the prediction of the effects of the implemented measures. The modelling by Herrmann et al. (2003) can be used as an example on how with the help of indicators frameworks for landscape development can be developed. These can then be used for the design of scenarios. This prognostic aspect of indicator implementation is also present in habitat modelling. Individual biotope characteristics are used here as key factors in the determination of habitat suitability of biotopes (Kleyer et al., 1992). Weber and Koehler (1999) also demonstrate this approach in modelling the dispersion of field larks on a defined landscape. Other modelling approaches simultaneously use sets of ecological and economic indicators to predict the economic and ecological effects of agricultural measures (see Meyer-Aurich and Zander, 2003).

Thus, many indicators have already been used in various development processes, in fact their use is not been questioned. Indicators are used in all types of sectoral planning that influence changes in landscapes and bio-diversity, for example, in landscape, urban, transport and forestal planning. While assessment systems with included indicators exist, the methods to land use development must be determined following. The evaluation in the framework of landscape planning processes are lacking in acceptance. Not-standardised and not-comprehensible methods play a significant role (Muessner and Plachter, 2002). But it is not sufficient to standardise methods because they are depending on justified indicators. Both have to be developed parallel.

6. Conclusion

The use of indicators was introduced in this article for the areas of assessment of agrarian and forestal enterprises, assessment of the efficiency of political measures, environmental reporting, planning and modelling. In general, the demands placed on indicators concern the analytical soundness, the measurability and their political relevance. Of great importance is their transferability and effort required for the data collection and availability of data. Due to

the different forms of implementation, some of these criteria are more problematic than others.

6.1. Assessment of agrarian and forestal enterprises

The assessment of the environmental compatibility of agricultural enterprises using a variety of point systems has been further developed in the past years, as shown in the summary by Braband et al. (2003). The preservation of bio-diversity and landscapes has been introduced here. The database is collected on site and is dependent on the availability of experts. The applied methods are partly implemented regionally in order to correctly assess the area of unused structures and the existence of different species. However, some experts are critical about the extent of the data collection. Therefore, approaches to reduce indicators by determination of correlations, as proposed by Oppermann (2003), will be of even greater importance in the future. In other views, farming systems (Knickel et al., 2001) and especially ecological farming is considered to be advantageous for the development of bio-diversity (Koepeke, 2002). This would mean that the type of farming would be used as indicator also for bio-diversity and landscape and not only for soil and water protection (see KOM, 2001a). This assumption is supposed to be verified by a current research project at the University of Kassel, Germany.

The political relevance of these farm-related indicators is given by the fact that decision makers and farmers receive information regarding the condition of the enterprises. From this information, recommendations for other enterprises or help with decisions concerning the own enterprise (compare Girardin et al., 1999) can be derived. Future developments of result-oriented indicator systems are possible.

Several experiences exist within the Dutch 'Yardstick for bio-diversity on farms-program' (Buys, 1995) showing an effect on initiative of farmers' own (Oosterveld and Guldmond, 1999).

Since some objectives can only be achieved after a long time, in certain areas measures must still be compensated. Independent of this, the objectives of the implemented measures should be known and their achievement grade evaluated in order to avoid a carry-on effect by the farmers. If the effects of in-

dividual measures are not clearly known, the necessity of research should be indicated (see evaluation of agri-environmental programs).

Apart from single farms, an increasing pressure is being placed on bigger agricultural and forestal enterprises also from abroad to prove ecological and, partially, social contributions. Commerce and consumers do not rely anymore only on governmental normative regulations and control procedures. Commerce and producers of agricultural products together determine production standards, production criteria in the ecological and social sector including the product quality.

All control systems have the same procedures and the same objective, but with different interest-oriented intention and motivation. The common aim is to prove, by documenting their actions, that the risks of plant production for humans and for the environment can be minimised to controllable criteria and that the voluntary control of these objectives shall complement governmental controls. In this regard, the intensity of biotic resource protection is represented varyingly. Biotic resources in forests and, in part, also in plantations of bananas, coffee, sugarcane, cacao and citrus fruits can be preserved as shown in the criteria of the Rainforest Alliance. In the protected cultivation of ornamental plants or vegetables under glass or foil, the possibilities of appropriate nature conservation of the production areas are limited. Therefore, it is recommended to implement measures outside the greenhouses. Bio-indicators that prove an increased bio-diversity beyond the measures of nature conservation are not used in any criteria system (see Section 2.2). On the contrary, it is assumed that biotic resource protection measures will per se have positive effects on bio-diversity. These pragmatic and controllable measures should be maintained and supported as long as no other economically and ecologically significant alternatives are available.

At the moment, neither the involved NGOs nor producers or commerce discuss the implementation of bio-indicators in criteria systems. On the contrary, there are still doubts if agrarian enterprises should undertake measures to improve bio-diversity. A future implementation of bio-indicators as control criteria to prove successful measures for improving bio-diversity should be connected to the following conditions.

The bio-indicator must

1. be, as far as possible, scientifically unquestioned;
2. be accepted by all participants of the control system;
3. be useful for all comparable agrarian eco-systems;
4. always exist with implementation of the measure;
5. be recognisable without using a special control procedure;
6. also be able to show the quality of the implemented measures;

The implementation of criteria systems to assess ecological performances of production enterprises as presently discussed and introduced on the international level, is always an intervention on the freedom of choice of the production and is, therefore, connected to a higher production cost. Since the implementation of the systems is voluntary, the economic effects on the enterprise must be taken into consideration as otherwise they will not be accepted in practice. In order to lower the cost of the operational assessment, key indicators should be developed. This would allow the simultaneous assessment of numerous control criteria by means of key indicators and thus reduce costs.

6.2. Evaluation of programs

The European Union requires a stronger control of already implemented agri-environmental programs (KOM, 2000). This assessment is not only of the implementation of the measures but also on their success (appendix D). It is therefore necessary to prove the efficiency of the promoted measures in a clear scientific manner. Although the control requirements were formulated EU-wide, the indicators will not be transferable since the implemented programs are differently oriented. Even here, the objective cannot be the determination of a uniform indicator set, but of a reliable assessment of these programs. This assessment, however, must be more than a statistic of the applied measures (compare Marggraf, 2003). Indicators which compare the situation before the introduction of the programs to the situation of the present evaluation and which are able to separate the effects of the programs still have to be determined. In this area of indicator application, the availability of data is still insufficient. However, the EU member states will be forced to comply with the requirements of the EU commission. For

this purpose, the inclusion of local surveying results is planned (compare Part D, KOM, 2000).

An evaluation of such agri-environment programs would be easier to accomplish, if in the biotic field, environmental observation systems would be more widespread. Maximum requirements, like “environmental random area sampling” (Statistisches Bundesamt and BfN, 2000) proposed in Germany, must be discussed with regard to a multiple use. Parallel to this, more scientific efforts should be made to determine the actual “necessary” number of groups of species to be examined for the characterisation of bio-diversity. Reporting in the area of protected habitats is better than the reporting of species groups. A national biotope surveying and, for example, the identification of FHH areas prescribed by law lead to these results. Therefore, the political relevance is very high. Alone for agriculturally used landscapes (which this article focuses on), the so-called “normal landscape” there exists a demand for action. Approaches to connect agrarian statistical data from the farmers’ subsidies applications (INVEKOS) with land use data (CORINE) have been made on the EU level (EEA, 2001) to gain a better understanding of environmental state. However, these approaches will only remain on the structural level and will not reach the bio-diversity level. Here national approaches are necessary. In Baden-Wuerttemberg, an inventory of all available target species groups including their potential distribution has built the basis which provided the target species concept (Walter et al., 1998).

However, with regard for landscape conservation, a uniform meaning of the expressions “intensively used”, “extensively used” and “not used” should be determined (compare OECD, 2001).

For the inclusion of interactions between biodiversity and landscapes, new aggregated indicators, Natural Capital index (NCI) (OECD, 2001, p. 316) should be developed, where the quality (change of the number of wildlife species emanating from a basic line) is multiplied by the quantity of the eco-system.

In order to secure structure indicators and their significance to bio-diversity, more research is necessary to find out the interaction of agricultural activity and habitats (fragmentation, heterogeneity, vertical vegetation structures) (OECD, 2001).

Whereas the term “bio-diversity” has a clear scientific meaning, the term “landscape” has a much

broader scope. Landscape as a concept (compare Wascher, 2000), the relation of structure, function and value of landscapes must be better understood (OECD, 2001). The definition of the adapted indicators must then follow. These aspects must be included in documentation about bio-diversity and landscape.

Because of the fascinating possibility of seeing into the future, the use of indicators in planning and modelling is of special political relevance. Due to the connection with the development of plans and/or visual scenarios, a strong decision-supporting character is given to the indicators. Their communicative function comes to the foreground.

Due to their relationships within the models, new contents, modifying their analytic consistency related to the problem, are given to indicators. In this case, the models extend the indicative expressiveness aiming at the connection of relevant aspects of a problem and the presentation of possible solutions.

The demonstration of the different applications of indicators shows that they are connected to different requirements. In general, indicators are used to describe complex systems difficult to survey (Girardin et al., 1999). They can diagnose or assess future developments. Girardin et al. (1999) propose a way to develop an indicator which, in the first step, defines its targets, determines the user in the second step and provides the actual development of the indicator in the third step. This always results in a compromise between the existing information, the state of science and the user's requirements regarding the indicator's grade of simplicity (Girardin et al., 1999). Therefore, the indicators can never be developed without considering the users' demands. The objective of science should be to work on a securitisation of indicators.

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